


IDENTIFYING MONETARY POLICY UNDER FIXED EXCHANGE RATES IN A SMALL OPEN ECONOMY

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ARTICLE INFO	ABSTRACT
<p>Article history:</p> <p>Received 30 June 2023</p> <p>Accepted 28 September 2023</p>	<p>Purpose: This paper is an empirical investigation of the transmission of monetary policy in a small open economy with fixed exchange rates. The paper argues that under a fixed exchange rate system and free mobility of capital, the ability of monetary policy actions to affect the real variables of the economy is limited and constrained by maintaining the peg.</p>
<p>Keywords:</p> <p>Monetary Policy Transmission Mechanism; Fixed Exchange Rates; Small Open Economy; Jordan.</p>	<p>Theoretical framework: The study's theoretical framework examines how Jordan's monetary policy, influenced by a fixed exchange rate with the U.S. dollar, responds to domestic and external shocks, with an emphasis on the transmission of these shocks through key economic variables.</p> <p>Design/Methodology/Approach: A two-country structural macroeconomic model has been developed to describe the small economy that explicitly incorporates an interest rate differential.</p>
	<p>Findings: Using Jordan as a case study during the period when its currency was pegged to the U.S. dollar, vector auto-regression analysis reveals that there is evidence of a strong U.S. monetary policy influence on the Jordanian economy. The results show that adjustment of the policy rate by the central bank of Jordan in response to Federal Reserve actions has no significant impact on output while the interest rate differentials tend to have an immediate influence on inflation with short lags, albeit small in magnitude.</p> <p>Research, Practical & Social implications: The research provides insights that can inform effective monetary policy strategies in small open economies like Jordan, offering implications for policymakers and contributing to economic stability.</p> <p>Originality/Value: The originality of this study lies in its comprehensive analysis of Jordan's monetary policy within the context of a small open economy, offering valuable insights into the effects of external shocks, exchange rate regimes, and policy responses on key economic variables.</p> <p>Doi: https://doi.org/10.26668/businessreview/2023.v8i10.3574</p>

IDENTIFICAR A POLÍTICA MONETÁRIA SOB TAXAS DE CÂMBIO FIXAS EM UMA PEQUENA ECONOMIA ABERTA

RESUMO

Objetivo: O presente documento constitui uma investigação empírica da transmissão da política monetária numa pequena economia aberta com taxas de câmbio fixas. O documento argumenta que, no âmbito de um sistema de taxa de câmbio fixa e da livre mobilidade de capitais, a capacidade de as medidas de política monetária afetarem as variáveis reais da economia é limitada e limitada pela manutenção da ligação cambial.

Estrutura teórica: A estrutura teórica do estudo examina como a política monetária da Jordânia, influenciada por uma taxa de câmbio fixa com o dólar americano, responde a choques internos e externos, com ênfase na transmissão desses choques através de variáveis econômicas chave.

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Concepção/Methodologia/Abordagem: Foi desenvolvido um modelo macroeconômico estrutural de dois países para descrever a pequena economia que incorpora explicitamente um diferencial de taxa de juro.

Constatações: Usando a Jordânia como estudo de caso durante o período em que sua moeda estava indexada ao dólar americano, a análise de autorregressão vetorial revela que há evidências de uma forte influência da política monetária dos EUA na economia jordaniana. Os resultados mostram que o ajustamento da taxa de política pelo banco central da Jordânia em resposta a medidas da Reserva Federal não tem um impacto significativo no produto, enquanto os diferenciais de taxa de juro tendem a ter uma influência imediata sobre a inflação com desfasamentos curtos, embora de pequena magnitude.

Investigação, Implicações práticas e Sociais: A investigação fornece conhecimentos que podem informar estratégias eficazes de política monetária em pequenas economias abertas, como a Jordânia, oferecendo implicações para os decisores políticos e contribuindo para a estabilidade econômica.

Originalidade/Valor: A originalidade deste estudo reside na sua análise abrangente da política monetária da Jordânia no contexto de uma pequena economia aberta, oferecendo informações valiosas sobre os efeitos de choques externos, regimes cambiais e respostas de política sobre variáveis econômicas fundamentais.

Palavras-chave: Transmissão de Política Monetária, Taxas de Câmbio Fixas, Pequena Economia Aberta, Jordânia.

IDENTIFICACIÓN DE LA POLÍTICA MONETARIA BAJO TIPOS DE CAMBIO FIJOS EN UNA PEQUEÑA ECONOMÍA ABIERTA

RESUMEN

Objetivo: Este artículo es una investigación empírica sobre la transmisión de la política monetaria en una pequeña economía abierta con tipos de cambio fijos. El artículo argumenta que bajo un sistema de tipo de cambio fijo y libre movilidad del capital, la capacidad de las acciones de política monetaria para afectar las variables reales de la economía es limitada y limitada por el mantenimiento de la paridad.

Marco teórico: El marco teórico del estudio examina cómo la política monetaria de Jordania, influida por un tipo de cambio fijo con el dólar estadounidense, responde a los shocks internos y externos, con énfasis en la transmisión de estos shocks a través de variables económicas clave.

Diseño/Methodología/Enfoque: Se ha desarrollado un modelo macroeconómico estructural de dos países para describir la pequeña economía que incorpora explícitamente un diferencial de tasas de interés.

Conclusiones: Utilizando Jordania como caso de estudio durante el período en que su moneda estaba vinculada al dólar de los EE.UU., el análisis de regresión automática de vectores revela que hay pruebas de una fuerte influencia de la política monetaria de los EE.UU. en la economía jordana. Los resultados muestran que el ajuste de la tasa de referencia por el banco central de Jordania en respuesta a las medidas de la Reserva Federal no tiene un impacto significativo en el producto, mientras que los diferenciales de tasas de interés tienden a tener una influencia inmediata en la inflación con breves retrasos, aunque de pequeña magnitud.

Investigación, Implicaciones prácticas y Sociales: La investigación proporciona información que puede informar estrategias efectivas de política monetaria en pequeñas economías abiertas como Jordania, ofreciendo implicaciones para los responsables de las políticas y contribuyendo a la estabilidad económica.

Originalidad/Valor: La originalidad de este estudio radica en su análisis exhaustivo de la política monetaria de Jordania en el contexto de una pequeña economía abierta, que ofrece valiosas perspectivas sobre los efectos de las perturbaciones externas, los regímenes cambiarios y las respuestas de política sobre variables económicas clave.

Palabras clave: Mecanismo de Transmisión de la Política Monetaria, Tipos de Cambio Fijos, Pequeña Economía Abierta, Jordania.

INTRODUCTION

Small open economies are more susceptible to external shocks and heavily rely on global economies. Some adopt a fixed exchange rate to maintain stability, limiting their monetary policy actions. Obstfeld and Rogoff (1995a) stated that under a fixed exchange rate with mobile capital, domestic interest rates are set abroad, restricting domestic monetary policy.

However, empirical studies (Obstfeld, Shambaugh, Taylor, 2004; Shambaugh, 2004; Frankel, Schmukler, Serven, 2004) found some flexibility in domestic monetary policy under a pegged exchange rate. Flexibility arises when rates move within a set band or due to regulatory barriers, especially capital mobility restrictions. Jordan, an open economy, has stabilized its dinar to the U.S. dollar for 27 years, limiting independent monetary actions. But, due to imperfect substitutability between Jordanian Dinar (JD) assets and foreign assets, Jordan's domestic interest rate varies from the U.S. rate.

This paper aims to analyze monetary policy shocks in a small open economy using Jordan as a case study. It will examine Jordan's monetary transmission in an open economy model identifying both domestic and external shocks to the economy. The methodology uses the Mundell-Fleming model and structural VAR econometrics. The paper is structured into sections: literature review, theoretical framework and methodology, empirical results, and conclusion.

LITERATURE REVIEW AND THEORITICAL FRAMEWORK

Small open economies, often unable to influence international prices, are more susceptible to external factors and global uncertainties. Openness to global markets can cause economic challenges like the monetary trilemma, as stated by Obstfeld (2004). To maintain exchange rate stability, some small economies prefer a fixed exchange rate and restrict capital movements. However, this stability often compromises the domestic monetary independence needed for output stabilization.

Under a fixed exchange rate, monetary policy's influence is limited, as discussed by Obstfeld and Rogoff (1995a). Bluedorn and Bowdler (2006) noted that with a pegged exchange rate, the domestic interest rate should match the foreign rate, which results in a lack of monetary autonomy. However, empirical studies have shown that fixed exchange rate systems don't strictly adhere to foreign interest rates, allowing some flexibility in domestic monetary policies.

Practically, monetary policy can exhibit independence in a fixed exchange rate regime, especially when the exchange rate moves within set limits or when there are regulatory barriers. For instance, the Mundell-Fleming model highlights the continuous capital flows due to variations between domestic and foreign interest rates. Moreover, Kamin et al. (1998) found that central banks have some autonomy under a fixed exchange rate.

Past research on monetary policy in small open economies primarily focused on flexible exchange rates. Studies on fixed rates, like those by Karamanou et al. (2004), Kakes (2000),

Disyatat and Vongsinsirikul (2003), and others explored the effectiveness of monetary policy through various economic channels. Regional studies like Al-Raisi et al. (2007), Rashid et al. (2018) and Murad et al., (2023) examined the monetary policy mechanism in Oman, Morocco and Iraq, respectively, revealing diverse results about the role of fixed exchange rates.

In Jordan, the literature on monetary transmission under fixed exchange rates is sparse. Noteworthy are the IMF studies by Poddar et al. (2006), Maziad (2009) and AL-Tamimi et al. (2023) that investigated monetary policies in relation to fixed exchange rates. This paper will further examine monetary transmission in Jordan under a pegged exchange rate regime, focusing on the central bank's ability to influence real variables. Recent studies, such as Obeidat et al. (2021) and Al Jarrah et al. (2016), investigated the monetary policy lending channels in Jordan, revealing varying degrees of effectiveness in the lending channels.

In examining monetary and financial factors' impact on aggregate fluctuations in a small open economy with a fixed exchange rate, Walsh (2017) presents a two-country framework. This framework assesses policy interactions under both exchange rate systems, assuming monetary policy is executed by controlling the nominal money supply. In a floating exchange rate, foreign price levels and shocks don't influence the small economy's price level, insulating output from foreign price fluctuations. Conversely, under a fixed rate, the economy's output and price levels are affected by foreign price factors, and domestic money supply disturbances are null. In such economies, the exchange rate regime and monetary policy significantly impact economic variables. This is further explained using a two-country framework similar to Walsh (2017) and an IS-LM framework as in Kakes (2000), which highlights the central bank's role in implementing monetary policy through the short-term interest rate. The small open economy model can be described by the following equations where all variables are expressed in log terms except the interest rate:

$$y_t = -\gamma r_t + \varphi \rho_t + \varepsilon_{yt} \quad (1)$$

$$m_t - p_t = \psi y_t - \omega i_t + \varepsilon_{mt} \quad (2)$$

$$\pi_t = \pi^* + \nu_t + \varepsilon_{\pi t} \quad (3)$$

$$i_t^S = i_t^{S*} + \varepsilon_{it} \quad (4)$$

Equations (1) and (2) are the IS and LM equations with standard assumptions concerning parameter signs. Equation (1) relates aggregate demand y_t to long-term real interest rate r_t , real exchange rate ρ , and real demand shock ε_{yt} . The real interest rate is from a Fisher

equation that links real to nominal interest rates: $r_t = i_t - (E p_{t+1} - p_t)$, or $r_t = i_t - \pi_t^e$ where the expected rate of inflation under a fixed exchange rate is equal to the foreign rate of inflation and a random white-noise disturbance (non-structural disturbance term), that is: $\pi_t^e = (E_t p_{t+1} - p_t) = \pi^* + v_t$. The real exchange rate is defined as: $\rho_t = s_t + p_t^* - p_t$ where s_t is the nominal exchange rate, p^* and p are the price of foreign and domestic output and an asterisk represents foreign variables. Equation (2) is a version of the money demand equation that relates real money demand to output, the nominal long-term interest rate i , and a money demand shock ε_{mt} where m_t is the nominal money supply.

Under a fixed exchange rate, the average rate of inflation is equal to the foreign inflation rate π^* , that is: $\pi_t \equiv (p_t - p_{t-1}) = (p_t^* - p_{t-1}^*) \equiv \pi_t^*$. This relationship implies that the foreign price p_t^* is equal to $\pi^* + p_{t-1}^* + v_t^*$, and the domestic price p_t is equal to $\pi^* + p_{t-1} + v_t$ where v_t is a random white-noise disturbance. Therefore, the inflation rate in the small economy in equation (3) is defined as the foreign rate of inflation and a domestic inflation shock $\varepsilon_{\pi t}$ that may reflect the supply side of the economy as well as a non-structural disturbance term v_t . In this model, the policy instrument is the short-term interest rate as it reflects the practice by which central banks implement their monetary policy. Under a fixed exchange rate, the monetary authority is committed to use its policy instrument i to maintain the peg – a constant nominal exchange rate – that satisfies uncovered interest parity which links nominal interest rates in both countries: $i_t = i_t^* + E_t s_{t+1} - s_t$. Therefore, the policy instrument within the context of pegged exchange rate in equation (4) is given by the nominal interest rate differential: $i_t - i_t^* = \lambda s_t + \varepsilon_{it}$ where $\lambda > 0$, and ε_{it} may capture factors affecting the difference in short-term interest rates and reflect monetary policy in the small economy.

Under a pegged exchange rate, the monetary authority in the small economy is committed to maintaining a constant nominal exchange rate. Given the assumptions that domestic and foreign assets are perfect substitutes as well as free capital mobility for the small economy, the no-arbitrage condition implies that domestic interest rate is equal to foreign interest rate. Therefore, the nominal exchange rate is normalized at $s_t = 0$ for all t if monetary authorities peg a fully credible fixed rate. By substituting the above definitions in the aggregate demand equation (1) and in the money demand equation (2), and assuming that the domestic and foreign long-term interest rates are equal, equations (1) and (2) can be expressed as:

$$y_t = \mu_{yt} - \gamma i_t^* - \varphi \varepsilon_{\pi t} + \varepsilon_{yt} \quad (1a)$$

$$m_t - p_t = \psi \mu_{yt} - (\psi \gamma + \omega) i_t^* + \psi \varepsilon_{yt} - \psi \varphi \varepsilon_{\pi t} + \varepsilon_{mt}, \quad (2a)$$

Where:

$$\mu_{yt} = \gamma\pi^* + (\gamma - \varphi)v_t + \varphi(p_{t-1}^* - p_{t-1}) + \varphi v_t^*.$$

The demand equations (1a), the money equation (2a), the inflation equation (3), and the interest rate equation (4) encapsulate the small open economy as a function of predetermined variables and structural shocks. The foreign price level and shocks as well as the nominal long-term interest rate affect domestic output under the pegged exchange rate. Furthermore, domestic disturbances to money demand ε_{mt} , have no output effects while real output shocks do. The IS in equation (1a) implies that: $dy_t/d\varepsilon_{yt} = 1$ and, $dy_t/d\varepsilon_{mt} = 0$. That is, under a fixed exchange rate, for any changes in money demand or shocks to the LM equation in (2a), corresponding changes in money stock can keep the nominal exchange rate fixed. The central bank has relinquished its ability to use monetary policy to stabilize output in favor of buffering money demand shocks.

In most small economies, however, foreign and domestic assets are imperfect substitutes, and there may exist some types of capital control under pegged exchange rate system that allow the domestic interest rate to deviate from the base country. The interest rate differential may then reflect these factors of the central bank monetary policy. By substituting the policy instrument $i_t = i_t^* + \lambda s_t + \varepsilon_{it}$ in equation (1), the model can be rewritten as:

$$y_t = \mu_{yt} - \gamma i_t^* + \frac{\varphi}{\lambda} (i_t^s - i_t^{s*}) - \frac{\varphi}{\lambda} \varepsilon_{it} - \varphi \varepsilon_{\pi t} + \varepsilon_{yt} \quad (5)$$

$$m_t - p_t = \psi \mu_{yt} - (\psi \gamma + \omega) i_t^* + \frac{\psi \varphi}{\lambda} (i_t^s - i_t^{s*}) - \frac{\psi \varphi}{\lambda} \varepsilon_{it} + \psi \varepsilon_{yt} - \psi \varphi \varepsilon_{\pi t} + \varepsilon_{mt} \quad (6)$$

$$\pi_t = \pi^* + v_t + \varepsilon_{\pi t} \quad (7)$$

$$i_t^s - i_t^{s*} = \lambda s_t + \varepsilon_{it} \quad (8)$$

As before, equations (5) to (8) constitute a four-equation system for real aggregate demand, money demand, the inflation rate and the short-term interest rate that represent monetary measures. In this case, the central bank through the interest rate differential is capable of affecting output. Whether the ability of the central bank to affect real variables is effective, depends on the particular parameterization λ and ϕ in the economy. The above system of equations that captures the peculiarities of the small open economy will be employed to identify

impulse-responses of structural shocks to output demand, inflation, money demand, and the interest rate differential for the Jordanian economy.

METHODOLOGY

The literature review indicates that VAR models, stemming from Sims' work in 1972 and 1980b, are pivotal in monetary transmission mechanism empirical research. They provide a multivariate system for analyzing macroeconomic variables. This paper will adopt the standard structural VAR, following the Sims-Bernanke and Blinder's approach, as outlined by Sims (1980b, 1992) and advocated by Leeper et al. (1996) to analyze policy shock dynamics. The method ensures the VAR model's alignment with economic theories and prior econometric beliefs. The feedback from real variables to the policy variable determines the policy variable's positioning.

For assessing the impact of monetary policy on real variables, the structural VAR model necessitates specific variables. In relation to Jordan's monetary framework discussed in previous section, the Jordanian VAR model comprises four endogenous variables presented as:

$$Y_t = (\text{Inflation, Policy, Output, Money})'$$

The identification restrictions of the Jordanian VAR model, aligning with the monetary framework model, imply that the central bank's primary objective is maintaining a fixed exchange rate. The central bank sets interest rates after observing the U.S. federal fund rate changes and does not instantly respond to inflation shocks. Within the VAR system, output is influenced by the interest rate and inflation but has no direct impact. The money equation (8) reacts instantly to all variable shocks to maintain the peg.

After ordering the vector of the structural shocks as $\varepsilon_t = (\varepsilon_t^{\text{Inflation}}, \varepsilon_t^{\text{Policy}}, \varepsilon_t^{\text{Output}}, \varepsilon_t^{\text{Money}})'$ based on the variables in the system, there are seven restrictions on the contemporaneous correlations for the identification of the four fundamental shocks. They lead to an over-identifying structure of the monetary transmission as in the matrix below:

$$B_0 = \begin{bmatrix} \beta_{11} & 0 & 0 & 0 \\ 0 & \beta_{22} & 0 & 0 \\ \beta_{31} & \beta_{32} & \beta_{33} & 0 \\ \beta_{41} & \beta_{42} & \beta_{43} & \beta_{44} \end{bmatrix}. \quad (9)$$

Given the ordering of endogenous variables in the basic model above, the baseline VAR model will consider a recursive structure between VAR innovations and the structural shocks. In this case there are six restrictions in the recursive VAR with policy variable ordered first. The inclusion of other variables such as foreign reserves, quasi money as well as exogenous variables will be considered too. The ordering is based on the speed with which the variables respond to shocks, with the U.S. short-term and long-term interest rate placed at the top of the ordering, for example, or as exogenous variables. Given that Jordan's economy has no impact on other economies, foreign variables are treated as exogenous in the VAR system, assuming it will only be affected by the U.S. monetary policy contemporaneously – a plausible small economy assumption. However, the peg with the U.S. dollar implies the inclusion of the U.S. interest rates as endogenous variables in the VAR model is acceptable from a statistical point of view (Kakes, 2000). The Central Bank of Jordan (CBJ) reaction function is represented by the primary interest rate, which reacts to the Fed actions.

The VAR model's variables align with the monetary policy framework for small open economies and include both endogenous and exogenous factors. Endogenous variables for Jordan encompass short-term interest rates, inflation, output, and a monetary aggregate. Bernanke and Blinder (1992) utilized the federal funds rate for policy decisions. For Jordan, the primary interest rate of the Jordan Central Bank is most appropriate. Real GDP is the chosen output measure for quarterly data, while the industrial production index (IPI) is preferred for monthly data, based on its correlation with output (Sims, 1992). Inflation is derived from the domestic consumer price index's log changes, and the broad monetary aggregate, M2, is incorporated. Data for these variables are sourced from the International Monetary Fund (IMF) and the CBJ database for the period 2009 to 2021. U.S. monetary variables, like the federal fund rate (FFR), ten-year Treasury Bills rate (TBR10), and U.S. inflation rate, are added due to their influence on Jordan's economy.

For data stationarity, unit root tests are executed. Results from the Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) tests indicating that most variables are integrated of order one, i.e., $I(1)$. The Johansen cointegration analysis on the VAR system indicates one cointegration equation at a five percent significance level based on the trace test.

RESULTS AND DISCUSSION

The first stage in the monetary transmission mechanism lies in the propagation of changes in the policy rates or money market rates through the banking system, especially retail

interest rates – i.e., interest rate pass-through. This is crucial for monetary policy to transmit its changes since banks are the main source of financing in Jordan. To analyze the dynamic effects of changes in the policy rate on the money market and retail rates, variance decompositions are calculated for both lending and deposit interest rates. The basic idea is to analyze the propagation mechanism of innovations to these shocks in the Jordanian financial system. Table 1 presents the share of fluctuations in retail interest rate variables that are caused by the CBJ policy shocks in the system. These variance decompositions of each variable are calculated at forecast horizons of one month to four years. The rows give the share of the variance due to each shock which add up to 100 percent.

Table 1: Variance Decompositions for Retail Rates

Period (Month)	Deposit Interest Rate			Lending Interest Rate		
	Policy Rate	Interbank Rate	Deposit Rate	Policy Rate	Interbank Rate	Deposit Rate
1	0.63	1.29	98.07	0.99	0.61	98.38
2	9.48	0.83	89.68	0.79	0.45	98.74
3	23.49	0.49	76.01	1.37	2.04	96.57
4	37.12	0.51	62.36	2.05	2.26	95.67
5	48.33	0.86	50.80	3.28	2.85	93.85
6	56.89	1.40	41.69	4.89	3.07	92.03
12	77.73	5.05	17.20	21.42	2.40	76.16
18	82.25	7.35	10.39	40.35	1.67	57.97
24	83.65	8.68	7.65	54.30	2.03	43.65
36	84.40	10.03	5.55	68.58	3.80	27.61
48	84.53	10.58	4.88	73.90	5.31	20.77

Source: results of statistical analysis Using E-views

The findings reveal that the initial month of policy rate shocks has no direct effect on lending and deposit interest rates. After six months, these shocks account for approximately 5% of lending rate fluctuations and 57% for deposit rates. Banks swiftly adjust their deposit rates to policy rate alterations, while lending rate adjustments are more gradual. A year later, policy rate shocks contribute to only 21% of lending rate fluctuations, with own shocks accounting for the majority.

In essence, the analysis suggests a weak interest rate pass-through from policy rates to bank rates. The consistent below-policy interbank rates indicate the Central Bank of Jordan's limited influence on market rates and its inability to wholly absorb market liquidity. Additionally, Jordanian banks exhibit a lag in adjusting deposit and lending rates during rising interest rate periods, implying a delayed impact of monetary tightening compared to easing policies. Generally, the monetary transmission mechanism in Jordan is less effective, aligning with CBJ's goal to maintain the peg to the U.S. dollar by offering higher domestic interest rates. This strategy reduces the potential outflow of liquidity to international markets. The subsequent

VAR analysis will delve deeper into Jordan's monetary transmission before establishing it as a standard characteristic of its economy.

Structural VAR Analysis

The baseline empirical specification of the VAR model to be estimated is:

$$Y_t = C + A_1 Y_{t-1} + A_2 Y_{t-2} + \sum_{i=0}^2 F_i X_{t-i} + B_0 \varepsilon_t, \quad (10)$$

Where:

$$\varepsilon_t \sim N(0; \Omega_4).$$

The vector Y_t encompasses endogenous variables such as consumer price inflation (INF), monetary policy (IRD), real output (GDP), and real monetary aggregates (M2), in line with theoretical constructs. The vector X_t denotes exogenous variables, notably the FFR. Vector ε_t is filled with fundamental disturbances, presumed normally distributed and uncorrelated at lags. Coefficient matrices are represented by A_1 , A_2 , B_0 , and F_i . The study evaluates various VAR model adaptations using quarterly data to inspect the real variables' response to monetary policy.

The optimal lag number for the VAR is derived from standard information criteria. The Schwartz-Bayesian Information (SBI) criterion favors a one-period lag, yet other metrics suggest four. Echoing this, Disyatat and Vongsinsirkul's (2002) evaluation of monetary transmission data for Thailand recommended a two-period lag for capturing the quarterly data's VAR system dynamics. As such, a two-period lag is employed, customary for quarterly data in empirical literature, ensuring residuals are devoid of autocorrelation (Morsink and Bayoumi, 2001; Disyatat and Vongsinsirkul, 2002). Given the VAR's stability, it's appraised in levels, enabling cointegrating relationships between variables. First difference estimation often omits crucial long-term relationships, making a level-based approach more elucidating. Moreover, with certain model variables being non-stationary—a trait frequent in financial data—VAR in levels with cointegrated variables yields consistent estimates, signifying if shock impacts are fleeting or enduring (Hamilton, 1994; Sims, Stock, and Watson, 1990; Butkiewicz and Ozdogan, 2009).

The analytical process kicks off with the over-identified VAR system's estimation. Table 2 displays parameter estimates, derived by constricting the theoretical model's inflation

equation. The over-identified constraint ($H_0: \beta_{21} = 0$) stands corroborated by the LR test statistics of Chi-square (1) = 1.36, marked at a 0.24 significance level.

Table 2: Estimates of the Over-Identified Var Model

Coefficient	Estimate	Standard Error	z-Statistic	Prob.
β_{31}	-0.014	0.008	-1.816*	0.0693
β_{32}	-0.002	0.011	-0.216	0.8285
β_{41}	0.009	0.003	2.961***	0.0031
β_{42}	0.010	0.004	2.351**	0.0187
β_{43}	-0.225	0.055	-4.055***	0.0001
β_{11}	0.899	0.095	9.380***	0.0000
β_{22}	0.612	0.065	9.380***	0.0000
β_{33}	0.048	0.005	9.380***	0.0000
β_{44}	0.017	0.001	9.380***	0.0000

Log Likelihood: 86.56418.

LR test for over-identification: $H_0: \beta_{21} = 0$. $\chi^2(1) = 1.357$ (Probability = 0.2441).

“***”, “**” and “*” indicate significance at 1%, 5% and 10% level, respectively.

Source: results of statistical analysis Using E-views

The parameters' estimates of the over-identified system are significant from zero except β_{32} although it has the expected sign. The results show that an inflation shock has a negative contemporaneous impact on output ($\beta_{31} = -0.014$) as expected, whereas its impact on real money demand is positive ($\beta_{41} = 0.009$). The results imply that a monetary policy shock affect output is negatively (although not significant), while its impact on the real money demand is positive ($\beta_{42} = 0.010$). However, the latter result is inconsistent with the theoretical model. The positive contemporaneous effect of an output shock on real money is inconsistent as the coefficient β_{43} shows. This result is in line with the response of real money to an output shock as the impulse response findings show below.

One notable feature of the estimates is that monetary policy impact on the Jordanian economy is very small in magnitude than in the case of economies with flexible exchange rates. For example, the linear contemporaneous relation for output innovation can be expressed as:

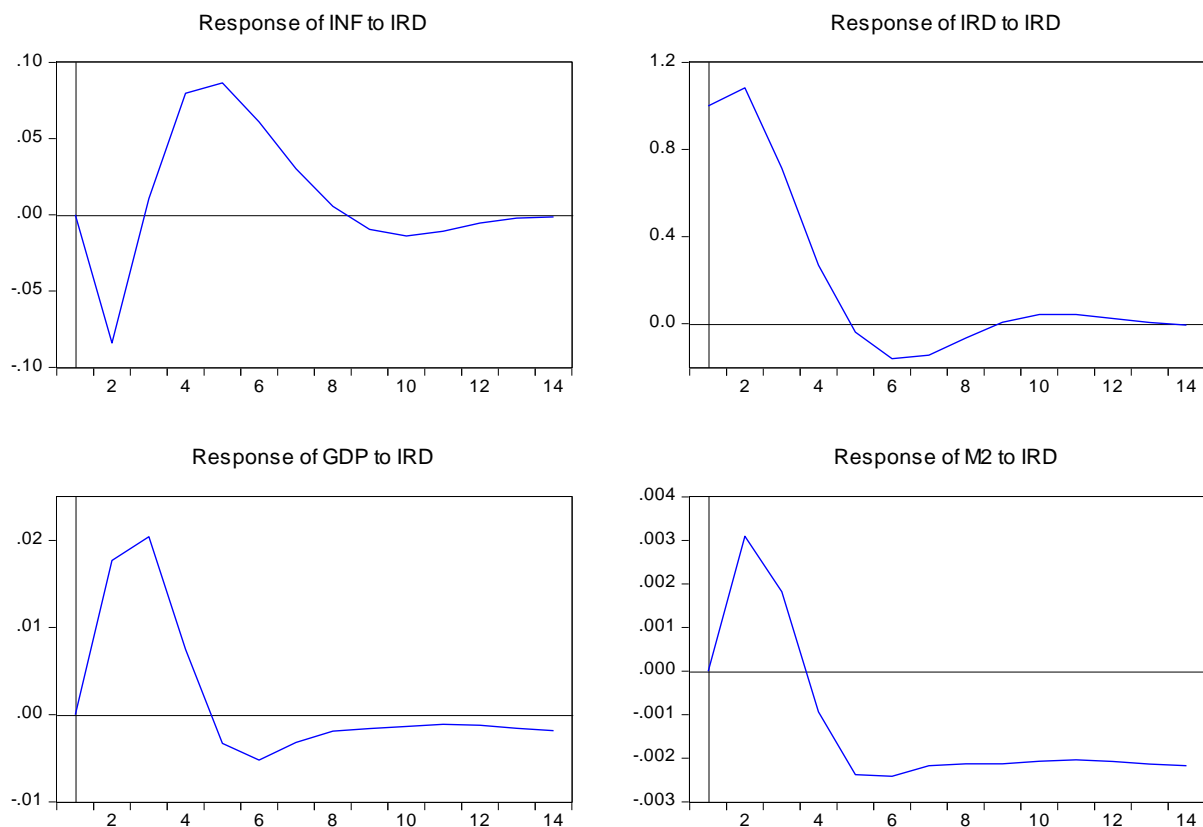
$$e_{GDPT} = -0.014e_{INFt} - 0.002e_{INTRDt} + \varepsilon_{GDPT}.$$

This relation shows that the point estimates of the simultaneous correlations reveal that a 100 basis point innovation in the interest rate differential leads to a contemporaneous 0.2 basis point fall in output within the quarter. As expected, the result suggests that the response of output is very small in magnitude. This result is consistent with the theoretical hypothesis of small open-economy models. That is, in small economies with pegged exchange rates and

unrestricted capital flows, monetary policy actions are constrained in affecting real economic activity.

The effects of an innovation to a particular variable on all the variables in the model are examined by computing impulse response functions. To see how the fundamental shocks which are identified by the basic model feed through into the economy, impulse response functions are estimated. These functions trace out the implied dynamic paths of the endogenous variables in the VAR system to a one-unit shock to one of the innovations in the system. Figure 1 shows the response of the economy to an interest rate differential shock.

Figure 1: The Estimated Response of the Economy to an Interest Rate Shock
Response to Cholesky One Unit Interest Rate Differential Innovations

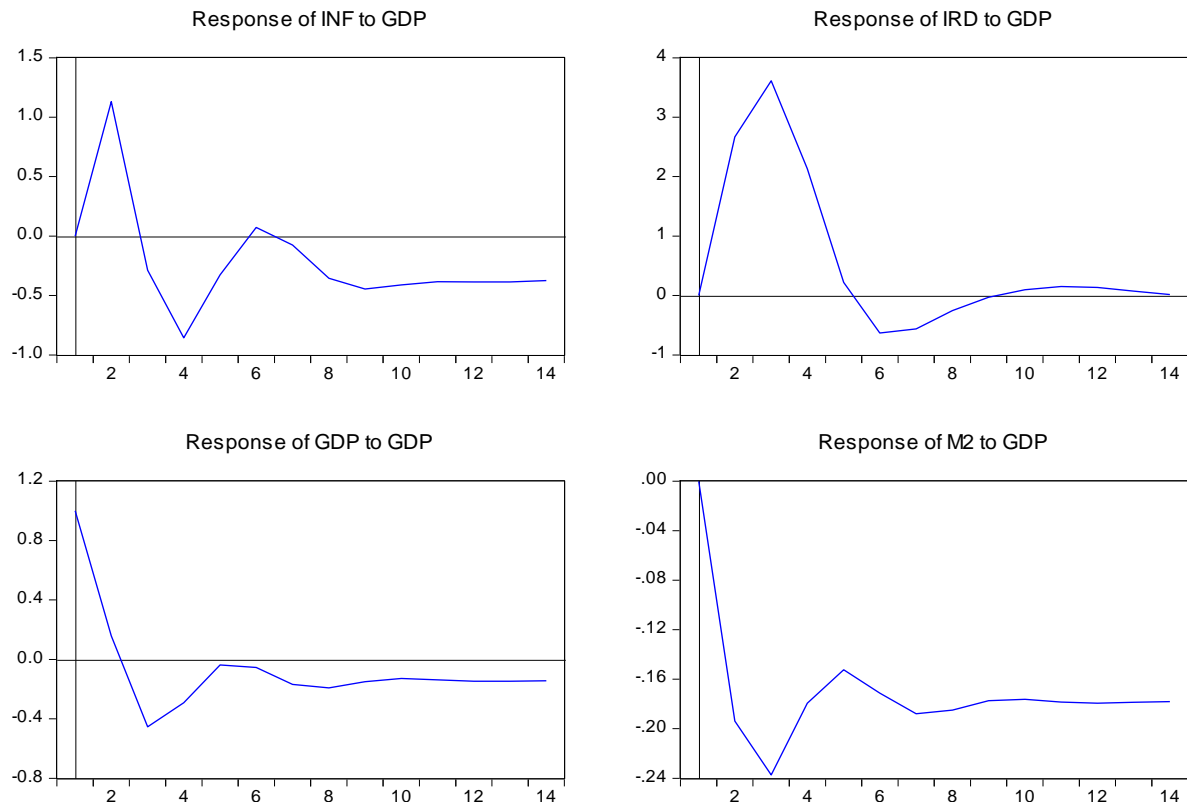


Source: results of statistical analysis Using E-views

Following a monetary policy tightening, consumer price inflation decreases, stabilizing in two years. However, output reduces with a delay and recovers after eight quarters. These trends are in line with the Central Bank of Jordan's goal to manage inflation through its JD peg to the U.S. dollar. The increased gap between the main interest rate and the FFR supports this peg. As shown in Figure 1, the interest rate differential initially surges, then returns to stability within three years. The real money supply's behavior, also in Figure 1, indicates a sustained

presence. In essence, an increase in interest rates boosts real output, likely due to Jordan's reliance on imported production materials, like crude oil, which become cheaper with a stronger exchange rate.

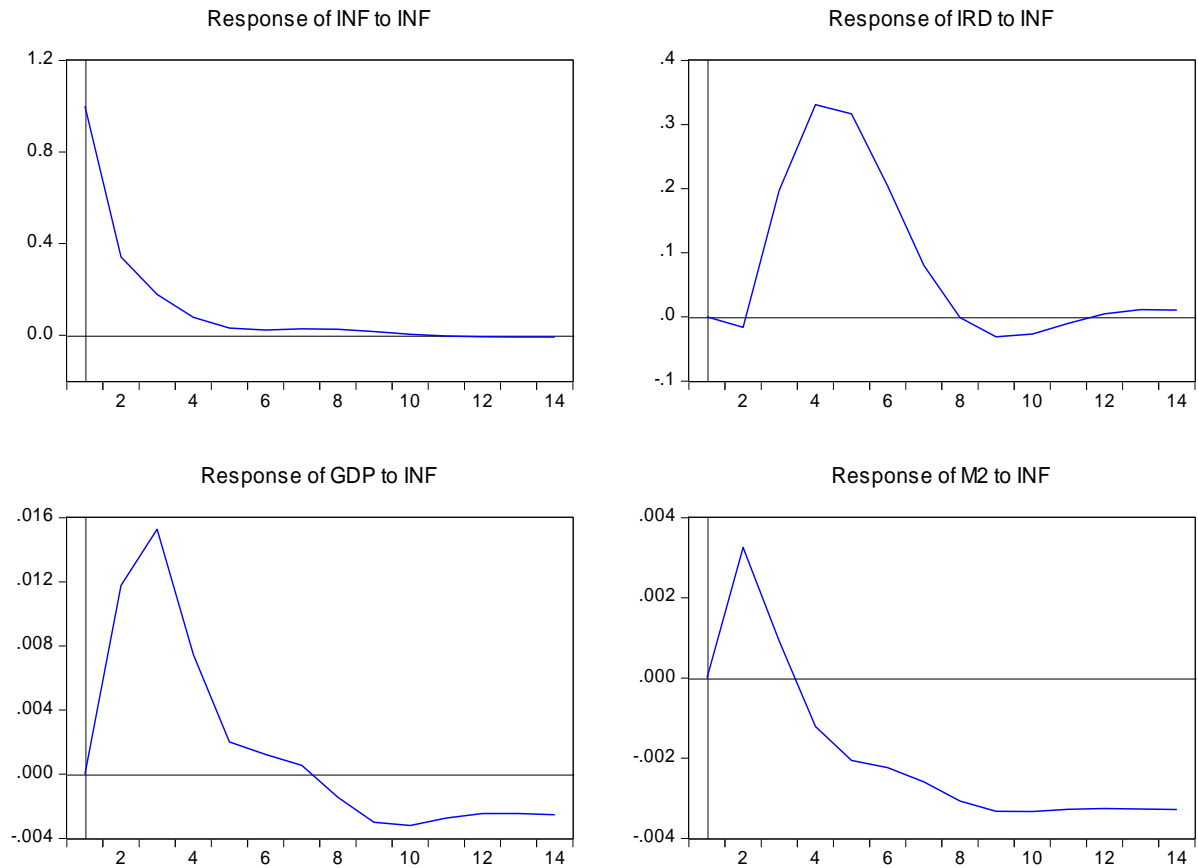
Figure 2: The Estimated Response of the Economy to an Output Shock
 Response to Cholesky One Unit Output Innovations



Source: results of statistical analysis Using E-views

Second, the effect of an output demand shock on the economy is illustrated in Figure 2. The right-hand panel shows an immediate response of tightening monetary policy by the central bank to stabilize the economy. The interest rate rises in response to a positive output shock in the first three quarters before it declines to its initial levels in the eighth quarter. In the upper left-hand panel, inflation rises in the first quarter and starts to decline in the second quarter to a positive demand shock. In the lower panels, output and money demand decline in a response to positive demand shock. However, the reaction behavior of the economy in response to a demand shock is hard to interpret. It is possible that the rise in interest rate seems to cause output and money demand to decline immediately and inflation to decline in the second quarter.

Figure 3: The Estimated Response of the Economy to an Inflation Shock
 Response to Cholesky One Unit Inflation Innovations



Source: results of statistical analysis Using E-views

Figure 3 reports the estimated responses of the economy to an inflation shock, i.e., supply shock to the economy. Interestingly, the responses of interest rate, output and money to an inflation shock tend to have the same pattern. The interest rate reacts with a lag and starts to increase at the beginning of the second quarter in response to inflationary pressure in the economy. It is puzzling, though, that the immediate drop in the interest rate differential is a response to a positive inflation shock in the first period. As a response to the negative supply shock, output starts to decline in the third quarter, reaching below its initial level in two years. At the same time, real money supply reacts in the same manner with more persistence below the baseline. Inflation declines significantly after a negative supply shock to the economy.

Table 3: Variance Decompositions for the Over-Identified Var Model

Period	A. Variance Decomposition of Output				B. Variance Decomposition of Real Money			
	INF	IRD	GDP	M2	INF	IRD	GDP	M2
1	7.24	0.09	92.66	0.00	7.78	6.76	23.25	62.20
2	9.68	1.74	84.27	4.30	8.28	6.09	12.64	72.97
4	8.16	2.27	71.29	18.26	13.37	7.17	6.62	72.82
6	7.98	4.44	62.42	25.14	16.09	8.59	5.48	69.82

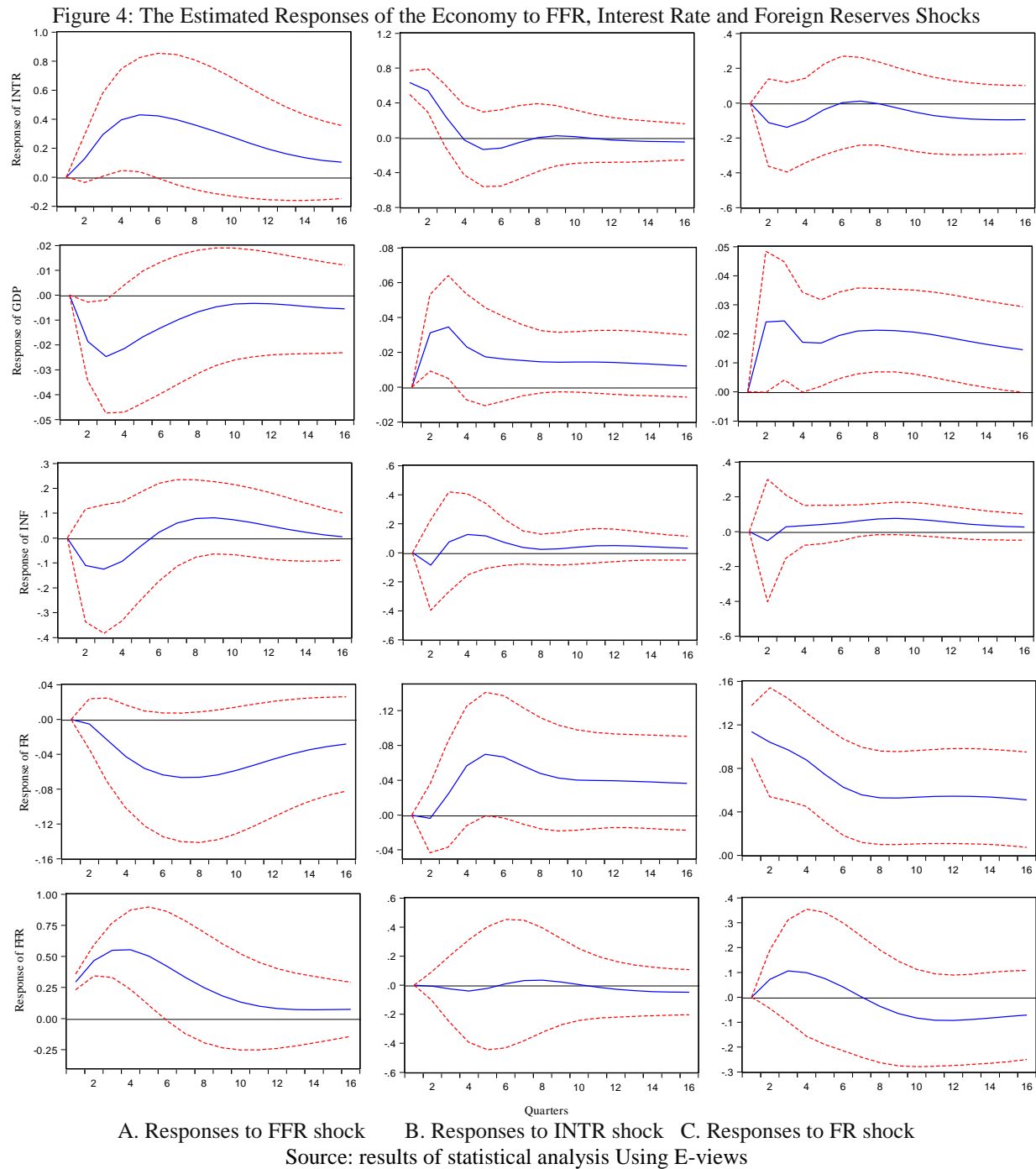
8	9.88	5.83	51.91	32.35	18.12	9.12	4.56	68.18
10	12.15	6.40	44.60	36.82	19.44	9.36	4.15	67.03
12	13.62	6.78	39.31	40.27	20.27	9.50	3.87	66.34
14	14.75	7.18	35.15	42.90	20.85	9.62	3.68	65.83
16	15.68	7.52	31.82	44.96	21.27	9.71	3.54	65.46
Period	A. Variance Decomposition of Interest Rate Differential				B. Variance Decomposition of Inflation			
Quarter	INF	IRD	GDP	M2	INF	IRD	GDP	M2
1	3.03	96.96	0.00	0.00	100.0	0.00	0.00	0.00
2	4.97	92.76	0.23	2.04	99.33	0.06	0.01	0.59
4	21.86	73.39	0.49	4.24	99.03	0.20	0.06	0.70
6	27.34	67.76	0.64	4.25	98.58	0.46	0.10	0.85
8	27.28	67.80	0.68	4.22	98.30	.048	0.12	1.08
10	27.32	67.77	0.68	4.22	97.83	0.57	0.13	1.45
12	27.30	67.78	0.68	4.22	97.31	0.66	0.15	1.87
14	27.32	67.76	0.68	4.23	96.84	0.71	0.16	2.27
16	27.32	67.76	0.68	4.23	96.38	0.76	0.18	2.67

Source: results of statistical analysis Using E-views

In summary, the interest rate differential's immediate impact on output is minimal, and it declines after a lag in monetary policy. However, it significantly affects consumer price inflation for a brief period, as reinforced by the variance decompositions (Panel C, Table 3). The real money supply's persistent behavior below the baseline might be due to its reaction to all variable shocks, aiming to maintain the exchange rate's stability. Forecast error variance decomposition (Panel B, Table 3) shows real money's influence by output, inflation, and the interest rate. Notably, monetary policy shocks contribute little to output variance. However, broad money shocks are significant, accounting for 47% of the total variations in output after three years, consistent with findings by Poddar et al. (2006).

To examine the relative importance of the interactions between the short-term interest rates in Jordan and the U.S., the VAR is extended with the FFR as an endogenous variable. Although this variable is exogenous in the model because Jordan's economy has no major impact on the U.S. economy, the U.S. interest rate policy is included as endogenous in the VAR model since the CBJ has the FFR in its information set when it adjusts its policy rate immediately after the Fed actions. In this case, the inclusion in the VAR model will capture the interactions between the two rates (Kakes, 2000). The FFR is put first assuming innovations in Jordanian variables have no immediate effects on Fed actions. In addition, the U.S. consumer price inflation is included as exogenous variable in the extended VAR as the Fed considers inflation when adjusting its policy rate. The CBJ usually adjusts its short-term interest rate in accordance with the Fed actions to maintain the peg to the U.S. dollar. The adjustment normally considers the accumulation of foreign reserves by the CBJ, which support the stability of the exchange rate. Therefore, the foreign reserves are included in the VAR – a plausible

assumption that reflects monetary policy stance in Jordan. The results of the impact of the U.S. monetary policy shock on the Jordanian economy are reported in Figures 4.



The results reveal that Jordan's short-term interest rate increases with a rise in the U.S. federal funds rate. U.S. monetary tightening causes a dip in foreign reserves and a decrease in inflation and output in Jordan, given the U.S. is a significant market for Jordanian exports. This aligns with the central bank of Jordan's goal to keep the peg to the U.S. dollar, raising interest

rates in response to U.S. hikes to prevent capital outflows. Variance decompositions (Table 4) emphasize the U.S. monetary policy's influence on the CBJ policy rate, with over 50% of the variance in Jordan's policy rate attributed to the FFR. Furthermore, CBJ adjusts its rates based on inflation, foreign reserves, and Fed actions. The inflation rate predominantly explains its own forecast variance, while foreign reserves immediately react to both Jordanian and U.S. short-term interest rates, reflecting CBJ's response to maintain substantial foreign reserves.

Table 4: Variance Decompositions for the Recursive Var Model

Period	A. Variance Decomposition of INTR					B. Variance Decomposition of GDP				
Quarter	FFR	INTR	FR	INF	GDP	FFR	INTR	FR	INF	GDP
1	14.41	85.59	0.00	0.00	0.00	0.19	1.39	5.81	12.03	80.57
2	19.18	79.05	1.00	0.12	0.65	1.48	9.62	11.16	14.55	63.18
3	28.63	60.98	2.63	6.23	1.54	1.65	15.89	13.26	15.74	53.45
4	36.70	45.20	3.45	13.25	1.40	1.52	18.49	14.44	16.51	49.04
6	48.16	31.04	3.14	16.53	1.15	1.61	19.03	17.00	17.49	44.86
8	54.86	25.90	2.75	15.14	1.34	2.58	18.41	20.13	17.17	41.71
10	57.42	23.84	2.75	14.70	1.30	4.17	17.89	22.78	16.29	38.87
12	57.82	22.84	3.00	15.10	1.24	5.68	17.59	24.54	15.61	36.58
16	57.53	22.10	3.50	15.66	1.21	7.22	17.52	26.45	15.05	33.76
Period	C. Variance Decomposition of INF					D. Variance Decomposition of FR				
Quarter	FFR	INTR	FR	INF	GDP	FFR	INTR	FR	INF	GDP
1	5.55	1.47	2.87	90.11	0.00	13.67	10.88	75.45	0.00	0.00
2	5.81	1.39	3.34	88.90	0.57	12.33	12.11	75.48	0.02	0.06
3	5.77	2.14	3.24	87.57	1.27	9.65	8.92	79.02	1.27	1.14
4	5.63	3.81	3.37	85.55	1.65	7.56	8.23	79.20	2.18	2.83
6	6.43	5.37	3.66	82.16	2.38	5.52	12.46	72.11	1.78	8.12
8	9.78	5.19	4.00	78.46	2.57	5.41	13.92	65.22	2.30	13.16
10	13.32	5.06	4.46	74.64	2.52	5.37	13.89	61.93	2.84	15.98
12	15.45	5.29	4.77	71.92	2.57	4.88	13.81	60.86	2.95	17.51
16	16.56	5.96	5.07	69.42	2.98	4.23	13.73	59.93	3.16	18.95

Source: results of statistical analysis Using E-views

The robustness of the VAR results is analyzed which showed stability results for both VAR models used in the analysis, the real roots are inside the unit circle which indicates that the models satisfy the stability conditions. For the first model, there are four endogenous variables while the second VAR model contains five variables.

An alternative approach to check VAR results for robustness is to estimate the model with different samples and different variables. By running the VAR on shorter samples, the results almost have the same shapes. Using other variables such as the repo rate as a policy rate, the results do not change much. Moreover, Pesaran and Shin (1998) suggested the estimation of the generalized impulse responses which do not depend on the order of the variables in the model. To conclude, the robustness analyses support the recursive and over-identified VAR results in this chapter to analyze monetary policy shocks in Jordan.

CONCLUSION

The purpose of this paper has been to identify and evaluate the monetary policy and non-policy shocks in Jordan, during a period where the CBJ has pegged the JD to the U.S. dollar. Given the fact that monetary policy in Jordan is aimed at maintaining the peg vis-à-vis the U.S. dollar, a monetary framework is constructed to uncover the dynamic effects of shocks on various domestic variables in the model. An over-identified VAR model is employed to evaluate and analyze the effects of shocks to four domestic variables of the Jordanian monetary framework, namely, interest rate policy, inflation, real output and a monetary aggregate. The U.S. short-term interest rate is included as exogenous in the VAR model. This is important in calculations of the impulse response simulations since the CBJ's monetary policy is tied with the Federal Reserve actions.

The main findings of the response of the Jordanian economy to a tightening of monetary policy are that consumer price inflation declines immediately, but starts to rise after two quarters before it returns to its steady state in two years. In response to inflationary pressure in the economy, the interest rate reacts with a lag and starts to increase at the beginning of the second quarter. Second, the results show that innovations in the monetary policy rate have no immediate and significant effects on real output in the Jordanian economy. A positive interest rate shock depresses output only after six months of the shock before it dissipates after two years. However, broad money in Jordan is found to be an important factor in explaining variations in output. After two years, variance decomposition results show that almost one third of the fluctuations in output are attributed to broad money, while the interest rate accounts for six percent. These results suggest broad money is more important in influencing real output in Jordan. The findings show that interest rate rises immediately to stabilize output in response to a positive demand shock.

These results imply that monetary policy in Jordan is aimed to maintain the peg to the U.S. dollar as the nominal anchor. They suggest that CBJ increases its policy rate in response to rising interest rates in the base country – the FFR. That is, by keeping higher interest rates than the base-country, the central bank is successful in maintaining its targeted level of foreign reserves that help to alleviate capital outflow and maintain the fixed exchange rate. The CBJ only reacts with monetary easing to higher level of foreign reserves. However, the CBJ is less successful in affecting real output by adjusting its policy rate. Given the peg of the JD to the U.S. dollar, the Jordanian economy reacts negatively to a rising short-term interest rates in the base country. The results show that output, inflation and foreign reserves decline in response

to a positive shock to the FFR. In brief, the findings in this chapter imply that using the short-term interest rate as a policy rate, monetary transmission is less operational under a fixed exchange rate regime. The findings are consistent with the theoretical hypothesis of small open-economy models. That is, in small economies with pegged exchange rates and unrestricted capital flows, monetary policy actions are constrained in affecting real economic activity. These findings are in line with Obstfeld, Shambaugh, and Taylor (2004) who found a strong foreign interest rate transmission to economies adopting a fixed exchange rate system in the post Bretton-Woods period.

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